Assessing the Zone of Comfort in Stereoscopic Displays using EEG

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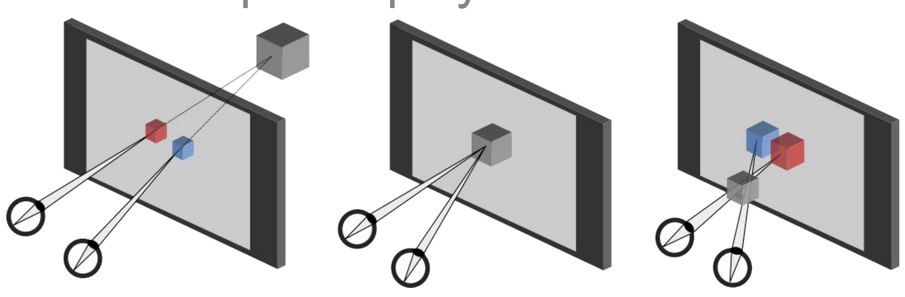
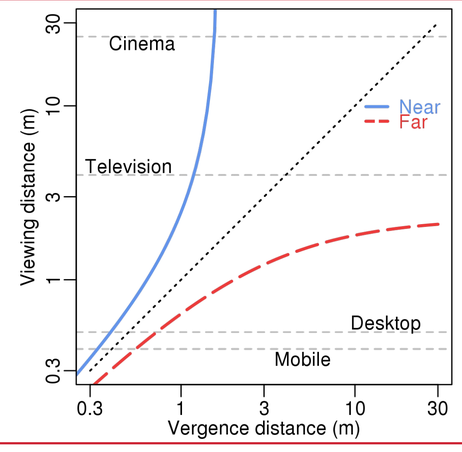
Introduction

The vergence-accommodation conflict (VAC) occurs in every stereoscopic display. It could cause discomfort.



A "zone of comfort" has been defined through questionnaires by [6], indicating VAC sustainable for viewers.



Fatigue studied with EEG: different EEG activity between a 2D display and a stereoscopic display [1,2,4]

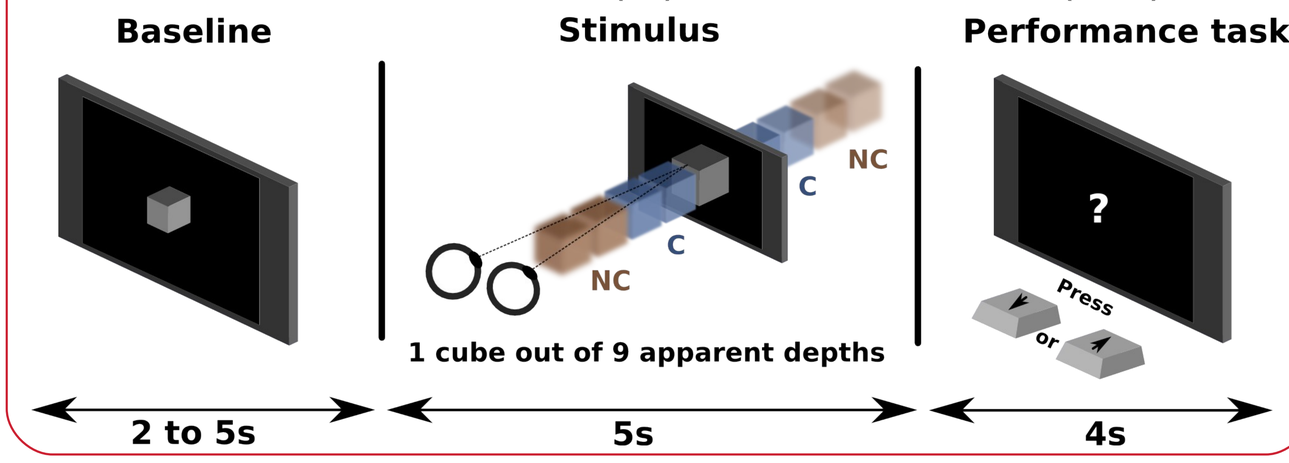
Combining EEG and VAC: are there differences in EEG activity between short sequences of different apparent depths?

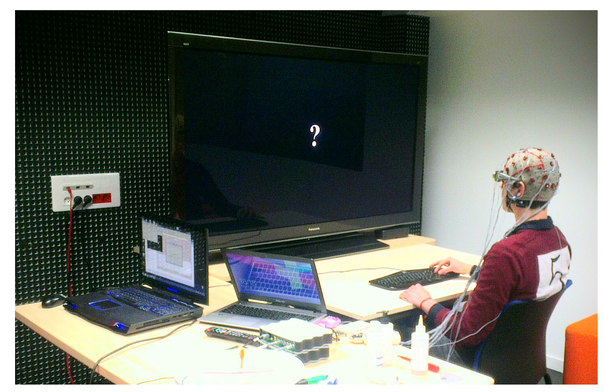
Real-time measures of visual comfort could allow quick tuning of stereoscopic displays parameters

Materials and methods

5-point Likert scale questionnaires: assessing vision clarity and eye comfort

2 conditions: comfort (C) and no-comfort (NC)





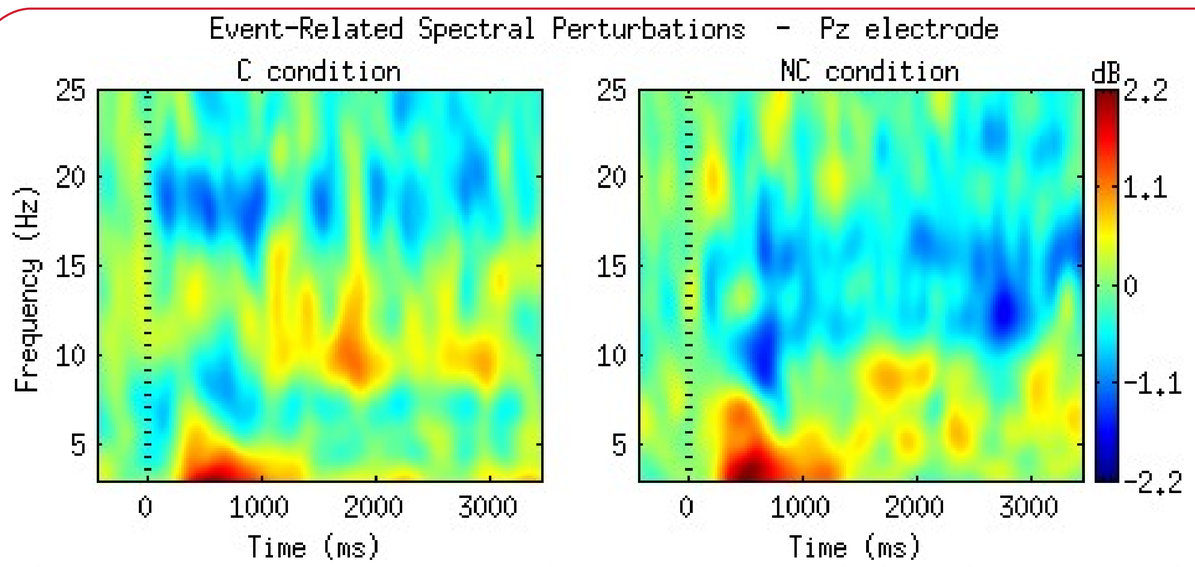
Performance task: cube behind or in front?

Hardware: g.tec 32 active electrodes & 65" active 3D TV. Software: OpenViBE [5] & EEGLAB [3]

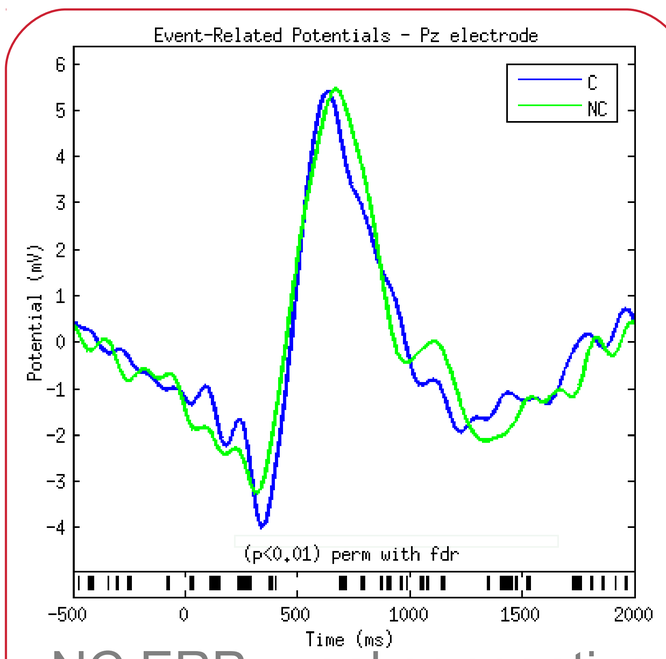
Results (3 subjects, 120 trials per condition, p < 0.01)

Questionnaires: symptoms more pronounced in NC
(C: 1.58 & 1.83; NC: 2.58 & 2.67)

Performance task: better score in NC
(C: 0.44; NC: 0.74; normalized [-1;1])



NC frequency power: decrease in alpha, increase in theta and beta bands



NC ERP: weaker negative peak and delayed positive peak after stimulus onset

Conclusion

We elucidated preliminary EEG correlates of visual comfort during stereoscopic display

References

[1] Chen, C., Li, K., Wu, Q., Wang, H., Qian, Z., and Sudlow, G. EEG-based detection and evaluation of fatigue caused by watching 3DTV. *Displays* (2013).

[2] Cho, H., Kang, M.-K., Yoon, K.-J., and Jun, S. C. Feasibility study for visual discomfort assessment on stereo images using EEG. *IC3D '12* (Dec. 2012)

[3] Delorme, A., and Makeig, S. EEGLAB: an open source toolbox for analysis of single-trial EEG dynamics including independent component analysis. *J. Neurosci. Meth.* (2004).

[4] Li, H.-C. O., Seo, J., Kham, K., and Lee, S. Measurement of 3D Visual Fatigue Using Event-Related Potential (ERP): 3D Oddball Paradigm. *3DTV-CON* (May 2008).

[5] Renard, Y., Lotte, F., Gibert, G., Congedo, M., Maby, E., Delannoy, V., Bertrand, O., and Lécuyer, A. OpenViBE: An Open-Source Software Platform to Design, Test, and Use Brain–Computer Interfaces in Real and Virtual Environments. *Presence-Teleop. Virt. 19*, 1 (Feb. 2010).

[6] Shibata, T., Kim, J., Hoffman, D. M., and Banks, M. S. The zone of comfort: Predicting visual discomfort with stereo displays. J. Vis. 11 (2011).

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